CLAIMS

1. A magnetic separator for separating magnetically responsive particles from a non-magnetic test medium in a path through an elongated non-magnetic container having an interior surface, the separator comprising:

magnetic means mounted exteriorly of said interior surface so as to generate a magnetic field strength within the container in which the magnetic field strength within the container is stronger in the test medium along the interior surface of the container than in the test medium more distant from the interior surface and is operative upon the magnetically responsive particles within the test medium to attract the magnetically responsive particles toward the interior surface of the container and cause such particles to be adhered to the interior surface, and

deflector means within the path in said container to deflect the magnetically responsive particles in said path toward the interior surface wherein said deflection means comprises:

a plunger operable to be displaced into said container to confront said interior surface and spaced therefrom to form an annular space through which said magnetic test medium may pass.

2. A magnetic separation apparatus according to claim 1 wherein said container has one size to facilitate test reactions in said test medium prior to

displacement of said plunger, and a second size in said annular space after displacement of said plunger to facilitate collection of the magnetically responsive particles from said annular space.

3. A magnetic separator for separating magnetically responsive particles from a non-magnetic test medium in a path through an elongated non-magnetic container having an interior surface, the separator comprising:

magnetic means mounted exteriorly of said interior surface so as to generate a magnetic field strength within the container in which the magnetic field strength within the container is stronger in the test medium along the interior surface of the container than in the test medium more distant from the interior surface and is operative upon the magnetically responsive particles within the test medium to attract the magnetically responsive particles toward the interior surface of the container and cause such particles to be adhered to the interior surface, and

deflection means within the path in said container to deflect the magnetically responsive particles in said path toward the interior surface, wherein said deflection means comprises:

a plunger placed in said path, said plunger having outside dimensions similar to but less than the inside dimensions of said interior surface to provide an elongated annular space along the length of the interior surface, said plunger being positioned in said

path to deflect the magnetically responsive particles in said path into said elongated annular space and toward the interior surface.

4. A magnetic separator for separating magnetically responsive particles from a non-magnetic test medium in a path through an elongated non-magnetic container having an interior surface, the separator comprising:

magnetic means mounted exteriorly of said interior surface so as to generate a magnetic field strength within the container in which the magnetic field strength within the container is stronger in the test medium along the interior surface of the container than in the test medium more distant from the interior surface and is operative upon the magnetically responsive particles within the test medium to attract the magnetically responsive particles toward the interior_surface of the container and cause such particles to be adhered to the interior surface, and

deflection means within the path in said container to deflect the magnetically responsive particles in said path toward the interior surface, wherein said deflection means comprises:

a stirrer positioned in said path to deflect the magnetically responsive particles in said path toward the interior surface.

5. A magnetic separation apparatus for separating magnetically responsive particles from a non-magnetic

test medium in a non-magnetic container having an interior surface, the separator comprising:

magnetic means having a gap receiving the container, said magnetic means generating a magnetic field gradient within the container in which the magnetic field strength within the container is stronger in the test medium along the interior surface of the container than in the test medium more distant from the interior surface and is operative upon the magnetically responsive particles within the test medium to attract the magnetically responsive particles toward the interior surface of the container and cause such particles to be attracted to the interior surface; and

a non-magnetic plunger operable to be displaced into said container to provide an annular space within said interior surface into which said magnetic test medium may pass.

6. The magnetic separation apparatus of claim 5 wherein said container comprises:

an elongated hollow cylindrical passage having an inlet for introducing the magnetic test medium into one end of the passage and an outlet for discharging test medium from the opposite end of the passage,

said interior surface being located between said inlet and said outlet.

7. The magnetic separation apparatus of claim 6 wherein said hollow cylindrical passage is configured

for conducting a flow of fluid therealong in a direction parallel to the longitudinal axis of the passage from said inlet to said outlet.

8. The magnetic separation apparatus of claim 6 wherein said gap of the magnetic means comprises a plurality of pole faces each disposed at an operative position exteriorly of said container adjacent said interior surface, said pole faces being disposed circumferentially of said cylindrical axis of the passage,

at least one of said pole faces being mounted for displacement radially outward from the axis of the passage to afford reduction of the magnetic field strength within the container, and thereby afford reduction of the attraction of said particles to said interior surface adjacent the operative position of said at least one pole face.

9. A magnetic separation apparatus for separating magnetically responsive particles from a non-magnetic test medium passing through a non-magnetic container having an interior surface, the separator comprising:

magnetic means generating a magnetic field gradient within the container in which the magnetic field strength within the container is stronger in the test medium along the interior surface of the container than in the test medium more distant from the interior surface and is operative upon the magnetically responsive particles within the test

medium to attract the magnetically responsive particles toward the interior surface of the container and cause such particles to be attracted to the interior surface; and

a non-magnetic deflector comprising a plunger having an outside dimension similar to but less than the inside dimension of said interior surface to provide an elongated narrow annular space along the length of said interior surface and operable to deflect magnetically responsive particles into said narrow annular space immediately adjoining said interior surface along which said magnetic test medium passes.

10. A magnetic separation apparatus according to claim 9 wherein said plunger is operable to be displaced into said container to confront said interior surface and spaced therefrom to form said annular space into which said magnetic test medium may pass.

11. A magnetic separation apparatus according to claim 10 wherein said container has one size to facilitate test reactions in said test medium prior to displacement of said plunger, and a second size in said annular chamber after displacement of said plunger to facilitate collection of the magnetically responsive particles from said narrow space.

12. A magnetic separation apparatus according to claim 9 wherein said container interior surface is carried by said plunger, and said magnetic means is mounted in said plunger and comprises pole faces directed toward said interior surface.

13. A magnetic separation apparatus according to claim 9 wherein said magnetic means has a gap with pole faces directed toward said gap, said container being positioned in said gap.

14. The magnetic separation apparatus of claim 13 wherein said magnetic means comprises each disposed exteriorly of said container adjacent said interior surface, the number of said pole faces being in the range of 8 to 64 faces disposed circumferentially of the axis of the passage.

15. The magnetic separation apparatus of claim 14 wherein the centers of pole faces are spaced apart by a distance not less than the distance between the faces and said internal surface.

16. The magnetic separation apparatus of claim 9 in combination with a container, wherein said container has thin wall section providing said interior surface, said thin wall section having a wall thickness in the range of 0.635 mm. to 0.100 mm.

17. The magnetic separation apparatus of claim 16 wherein said wall thickness is approximately 0.100 mm.

18. A method for separating magnetically responsive particles from a non-magnetic test medium flowing in a path through an elongated non-magnetic container having an interior surface, comprising the steps of

generating a magnetic field strength within the container in which the magnetic field strength within the container is stronger in the test medium along the interior surface of the container than in the test medium more distant from the interior surface and is operative upon the magnetically responsive particles within the test medium to attract the magnetically responsive particles toward the interior surface of the container and cause such particles to be adhered to the interior surface, and

deflecting the magnetically responsive particles in said flow toward the interior surface.

19. A method according to claim 18 wherein said step of deflecting the magnetically responsive particles is achieved by positioning baffles in the flow path to direct the flow along said interior surface.

20. A method according to claim 18 wherein said step of deflecting the magnetically responsive particles is achieved by passing the particle-laden

test medium through a sprayer to direct the flow along said interior surface.

21. A method according to claim 18 wherein said step of deflecting the magnetically responsive particles is achieved by positioning a stirrer in the flow path to direct the flow along said interior surface.

22. A method according to claim 18 wherein said step of deflecting the magnetically responsive particles is achieved by displacing a plunger into the flow path along said surface to reduce the thickness of the flow path along said interior surface.

23. A method according to claim 18 including the additional step of enhancing the magnetic field strength within the container along said interior surface by using a thin wall as the interior collection surface.

24. A method for performing a bioparticle separation and resuspension comprising the steps of separating magnetically responsive particles from a non-magnetic test medium passing in a path through an elongated non-magnetic container having an interior surface by generating a magnetic field strength within the container in which the magnetic field strength within the container is stronger in the test medium along the interior surface of the container than in the test medium more distant from the interior surface

and is operative upon the magnetically responsive particles within the test medium to attract the magnetically responsive particles toward the interior surface of the container and cause such particles to be adhered to the interior surface, and deflecting the magnetically responsive particles in said container toward the interior surface, and

thereafter removing the high-gradient magnetic field from the interior surface to resuspend said adhered particles into the test medium in said container.

25. A method for selection of magnetically labeled substances in a container placed near a magnetic means wherein the thickness of the wall of the container, the material of the collection surface of the container wall, the number and spacing of the magnets constituting the magnetic means and the separation space within the container is optimized such that the highest magnetic gradient is obtained as well as the desired distribution and holding force of the magnetically labeled substances on collection surface.